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Delayed Bud Initiation in Black Spruce Container Seedlings Due to Accidental Daylength Extension

by

S.J. Colombo[1] and W.A. Smith[2]

Introduction

The formation of terminal buds is a prerequisite to the development of winter hardiness in black spruce container seedlings. In the first year of growth, greenhouse-grown spruce seedlings rely upon declining daylengths in the fall to stimulate the change from free growth to bud initiation (Heide 1974). Bud initiation may be prevented by extending the daylength using artificial lighting (Arnott and Mitchell 1982), a procedure which may be employed when a crop is shorter than the minimum acceptable height due to late sowing. However, the later buds are initiated, the later will seedlings gain sufficient hardiness to withstand damage from frosts after being moved outside for overwintering (Colombo 1982).

The purpose of this note is to describe an apparent case of unintentionally delayed bud initiation, which occurred during hardening of a black spruce container seedling crop.

Materials and Methods

Observations were made in one greenhouse at a container tree seedling nursery located near Iroquois Falls (Lat. 48°46'N, Long. 80°41'W). Seedlings were from a Kapuskasing District seed source (Lat. 48°43' to 50°30'N and Long. 81°51' to 83°26'W).

Five sampling locations along the length of one greenhouse bay were chosen to reflect a visual gradient in bud initiation, apparently varying with distance from a nearby outside high intensity mercury vapour yardlight, i.e. latest budset nearest to the light. Twenty-two to 25 shoot tips (terminal 2-3 cm of main stem) were collected on September 19, 1983

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[1]Ontario Tree Improvement and Forest Biomass Institute, Ministry of Natural Resources, Maple, Ontario.
[2]Formerly Production Manager, Northern Greenhouse Farms Ltd., Iroquois Falls, Ontario. Present address AguaNorth Inc., P.O. Box 390, North Bay, Ontario.

Further information may be obtained from:

Ontario Tree Improvement and Forest Biomass Institute
Ministry of Natural Resources
Maple, Ontario L0J 1E0

from 2 paperpot trays at each location, 17, 20, 32, 56 and 85 m from the light. Light intensity from the yardlight was measured at each collection site during cloudless weather at 2300 h on October 18, 1983, using photometric and quantum sensors of a Li-Cor Model LI188B integrating photometer.

Collected shoot tips were dissected according to the methods of Pollard (1973) and Colombo et al. (1982) to determine the percentage of seedlings with terminal buds initiated and the number of needle primordia present when buds were found. Significant differences in the average number of needle primordia in seedlings at different collection sites were identified using a one-way analysis of variance and LSD test (2.5% level) (Freese 1967).

Results and Discussion

Significantly fewer needle primordia were present in the buds of seedlings within 20 m of the yard light (Fig. 1). At a distance of 20 m seedlings had an average of 50 needle primordia and 92% bud initiation. At a distance of 56 m buds contained an average of 74 needle primordia, significantly more primordia than at 20 m from the light ($P<0.025$). At the nearest point to the light (17 m) 83% of the seedlings had initiated buds and on average contained only 26 needle primordia, significantly fewer primordia than at any other collection site.

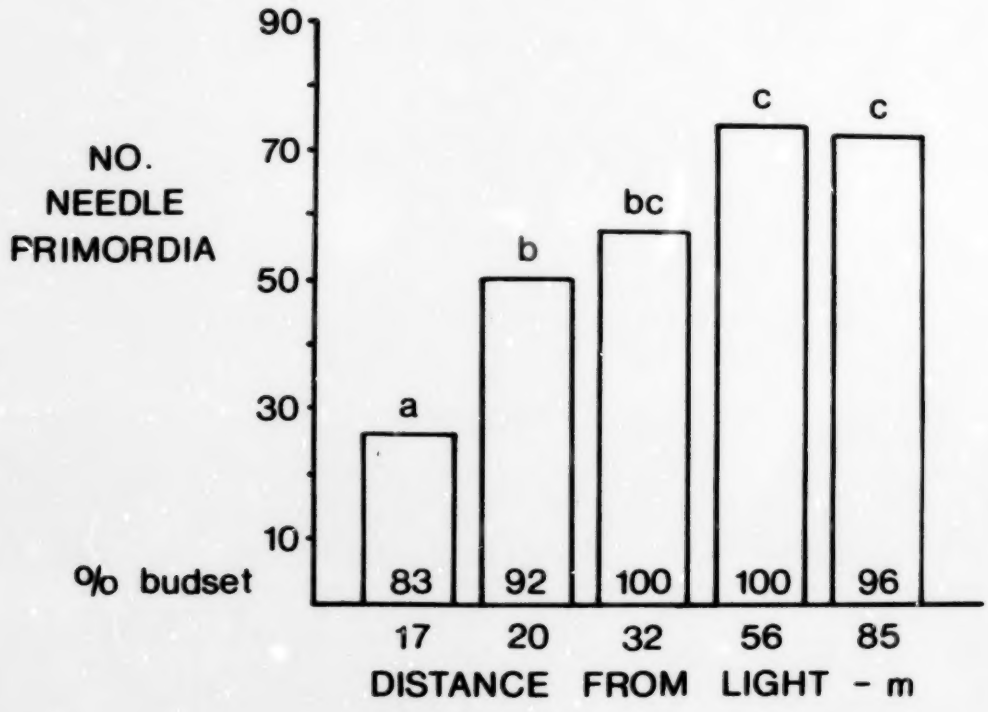

Figure 1 Number of needle primordia in terminal buds of black spruce paperpot seedlings in relation to distance from a yard light. Columns headed by the same letters do not differ significantly at the 2.5% level.

Light intensity dropped rapidly as distance from the yard light increased. Directly under the light, intensity was 77.5 lux; at the first tray, 17 m away, light intensity was 3.0 lux and, at 20 and 32 m, 0.28 and 0.18 lux respectively. In terms of light energy ($\mu E.sec^{-1}.cm^{2}$) the values were 0.053 at 17 m, 0.012 at 20 m and 0.005 at 32 m. Beyond 32 m, light intensity was too low for measurement in either lux or μE.

When a spruce crop is being prepared for overwintering, seedlings which have been slow to initiate buds will be the last to reach high levels of winter hardiness. Seedlings which are placed outside before they have achieved a sufficient level of hardiness may suffer damage from fall frosts (Colombo 1982, Colombo et al. 1982). Delayed bud initiation due to accidental daylength extension will lead to a lack of uniformity in hardening within a greenhouse, which is a serious problem.

A solution to this problem would be to turn off all lights from the end of July to the end of September near greenhouses containing black spruce seedlings, after which time bud initiation should be complete. Alternatively, as daylength extension occurs in plants in response to long wavelength (red and far-red) light (Leopold and Kriedemann 1975), yard-lights which emit primarily short wavelength light could be used in place of mercury vapour lamps, which emit light of long wavelengths. Where lights are present which cannot be turned off or replaced, for example, in the case of street lamps, seedlings could be shielded from the lights using opaque covers.

The light intensities found to be associated with delayed bud initiation in this study are very much lower than those previously reported for white spruce (P. glauca (Moench) Voss) and Engelmann spruce (P. engelmannii Parry) (Arnott 1979, Arnott and Mitchell 1982). However, Arnott's studies were conducted using older stock (sown April 13, versus June 11 in this study), with light treatment taking place in a shade house lacking temperature control. In our study, seedlings were kept in a heated greenhouse during bud development. Differences in type of lamp, air temperature, seedling age and species could have resulted in sensitivity to light of even low intensity (from 0.18 to 3.0 lux) in this study.

The preparation of spruce container stock for overwintering requires the control of environmental factors, including daylength, as winter hardiness develops. These results demonstrate the need for nurserymen to be aware of the influence which nearby lights can have on delaying bud initiation and winter hardiness development of black spruce container seedlings.

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